Study of Li-Ion Conducting Polymer- Inorganic Composite Materials

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Abstract

Solid-state lithium-ion conductors are attractive materials for next-generation secondary batteries owing to their advantages such as high energy density, compactness, and safety. However, their practical application faces several resistive issues. Thus, the interpretations of the lithium-ion transporting mechanism as well as the development of solid-state lithium-ion conductors are required for the successful practical application of solid-state lithium-ion conductors.

This dissertation presents the designed novel polymer/inorganic composite materials, where inorganic ion conductive particles are embedded as a single layer in the polymer matrix. The lithium-ion transfer mechanisms of these designed composite materials are carefully investigated via AC impedance spectroscopy. These composite materials exhibit surprisingly higher ionic conductivities and considerably lower activation energies than the commercial and sintered inorganic ion conductors because of the fast ion-transport pathways. Furthermore, the processing of the composite materials is discussed and a method to control the factors related to ionic conductivity is demonstrated. Finally, the battery characteristics in using the composite materials in batteries as well as the phenomena of lithium dendrite suppression in terms of lithium metal usage are discussed to express the possibilities of application to the batteries. These approaches result in the implementation of new opportunities for composite materials to be used in practical applications, including in all-solid-state lithium-ion batteries.